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Benefits of an International Database for UF6 Cylinders

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A reasonable expectation regarding the nuclear energy renaissance is that the location of fuel cycle nuclear materials throughout the world will be known. We ask - would an international system for uranium hexafluoride (UF_6) cylinders provide the effective assurances expected for international fuel supply and of the international fuel centers? This paper introduces the question and discusses the potential benefits of tracking UF_6 cylinders through the development of an international database. The nonproliferation benefits of an international database for UF_6 cylinders being used in the fuel cycle include an enhanced capability to reconcile nuclear material imports and exports. Currently, import and export declarations only require the reporting of total "rolled up" quantities of nuclear materials contained in all items – not the quantities of materials in individual items like individual UF_6 cylinders. The database could provide supplier countries with more assurance on the location of the UF_6 cylinders they export. Additionally, a comprehensive database on all declared cylinders would be a valuable resource in detecting and recognizing undeclared cylinders. The database could potentially be administered by the IAEA and be accessible to authorized countries around the world. During the nuclear renaissance, the general public, as well as the participants will expect transparency and quality information about movement of nuclear fuel cycle nuclear materials. We will discuss the potential benefits of such a database for the suppliers, inspectorates, and general public.

Introduction

With the current and expected increase in the deployment of nuclear energy, challenges to the global nuclear nonproliferation system will increase significantly. This paper will look at the potential approach to strengthening assurances related to uranium hexafluoride (UF_6) in the front end of the fuel cycle by tracking not just the nuclear material but also the containers in which it is shipped and stored. There are a finite number of countries engaged in the nuclear fuel cycle supplying fuel to nuclear power plants and research reactors. For nearly three decades there have been only a few States interested in adding nuclear power plants to their energy grids, because of cost, public opinion and safety concerns. Now that many States are again (or for the first time) considering nuclear power, the world community needs to reexamine safeguards and security regimes to identify gaps or indicators of non-peaceful use of nuclear materials by State or non-State actors.

Why would UF_6 cylinders need special tracking?

Most UF_6 in Non-Nuclear Weapon States (NNWS) already is subject to IAEA safeguards and associated reporting and verification mechanisms that provide substantial assurances

about non-diversion and peaceful use. What advantages do we envision would be gained by also tracking the cylinders themselves? These could include one or several of the following:

- A cylinder tracking scheme could extend beyond the scope of IAEA safeguards to provide more comprehensive coverage, especially for material used in civilian nuclear programs of nuclear weapon states.
- The tracking system would facilitate easier, more accurate transit matching of UF_6 shipments and receipts.
- The system would provide more direct assurances to suppliers regarding the destination and point of use of supplied material.
- A tracking system that also provided for periodic verification of cylinder tare weight and cylinder heels could improve the fidelity of UF_6 material accountancy.
- Tracking cylinders even after their contents are introduced to the process areas of recipient-state facilities would provide deterrence against the misuse of empty cylinders in support of undeclared nuclear activities
- In the case that registration and tracking of all legitimate civilian-use UF_6 cylinders should become a widely adopted practice, detection of unregistered cylinders in a state would be a potential indicator of undeclared nuclear activities.

There are some precedents for tracking items in nuclear commerce beyond what is required under IAEA safeguards.

Countries involved in nuclear material transactions typically do so under bi-lateral and/or multi-lateral arrangements (nuclear cooperation agreements, export license conditions, etc.) that may specify obligations or reporting requirements that reinforce or supplement IAEA reporting requirements. Exporting states might, for example, require prior consent for retransfer or additional processing, or might reserve the right to conduct post-delivery verification that an exported item has been spent to the declared end-use location and that physical protection measures are adequate.

Current IAEA reporting requirements for UF_6

The NNWS signatories to the Nonproliferation Treaty (NPT) the location and quantity of UF_6 contained in cylinders is reported to the IAEA. Review of accounting reports, matching of shipper and receiver data, and physical verification activities all contribute to assurances that the material is accounted for and has not been diverted to other purposes. The IAEA tracks the material through nuclear material accounting, inspections and NPT transit matching of shipments with receipts, thereby following the corresponding cylinders for each NNWS. The nuclear material accounting reports (inventory changes) for each transfer are required to be reported on a batch basis. Based on the relevant facility attachments, the standard approach is for one reporting batch of nuclear material to represent one cylinder, that is, detailed information including location, quantity, and

composition most often is reported at the individual cylinder level. One of the details reported is a batch "Identification Number," and some States utilize the cylinder identification (serial number) as the reported batch name. In such cases, each movement of a UF_6 cylinder into or out of a material balance area would appear as a separate entry in an inventory change report, and each cylinder in storage would appear as a separate entry in a physical inventory listing. The IAEA also tracks all domestic transfers within each NNWS, and those are reported on a single batch (cylinder) basis. In the event there are domestic transfers among safeguarded facilities within a single Nuclear Weapon State (NWS), the IAEA would track those as well, batch by batch.

There are three primary safeguards instruments by which movements of UF_6 cylinders are reported to the IAEA:

- INFCIRC/153 type comprehensive safeguards agreements for NNWS;
- Voluntary offer safeguards agreements for NWS;
- INFCIRC/207 export/import notifications for NWS.

All NNWS with an INFCIRC/153 type comprehensive safeguards agreement are required to report the transfer of all UF_6 nuclear material batches, which covers imports, exports and domestic movements. All quantities, no matter how small must be reported, and this includes heels remaining after a cylinder has been emptied. It should be noted, however, that for new cylinders that have never contained UF_6 or for those that have been cleaned out (e.g. in the process of recertification) there is no requirement to report the movement, as long as there is no nuclear material in a cylinder. For NNWS, all transfers are on a batch basis, regardless of the amounts.

Safeguards under a NWS voluntary offer agreement is implemented by the IAEA only for selected facilities. Once selected, those facilities are required to report all transfers of nuclear material, batch by batch as defined in the relevant facility attachment. However, not all facilities in the civil sector of a NWS are selected for IAEA safeguards and therefore, transfers of UF_6 with NNWS are instead reported under the arrangements specified by INFCIRC/207.

INFCIRC/207 provides the NWS with a mechanism for informing the IAEA on all exports of nuclear material to NNWS and all imports of nuclear material that was subject to safeguards just prior to export. Further, INFCIRC/207 sets a limit of 1 effective kilogram (EKG), below which a report is not required.

With the specific case of low enriched UF_6 and the 1 EKG limit for INFCIRC/207, in practice (and if the other requirements of INFCIRC/207 are met) a report would always be required for a full cylinder of low enriched uranium. Although it is technically possible that several full cylinders could be combined into a single INFCIRC/207 export report to the IAEA, in practice this is generally not the case, and each cylinder is reported separately

What would be needed in order to implement tracking?

There are an estimated 40 – 50 companies from 15 – 20 countries worldwide engaged in some aspect of fuel fabrication and there are approximately 13 enrichment facilities. This is a manageable number of organizations and States who, at least for the NNWS, are already reporting to an international system. But tracking cylinders in addition to material entails some additional complexities.. There are initial measurements for tare weight, which will have changes over the life of the cylinder. The purchaser and 'owner' of the cylinder might be the fuel production company or could be the nuclear power utility that is the customer for the fuel. Who tracks and has responsibility for the cylinder over its life? It seems facilities and the IAEA inspectors would benefit from knowing when a cylinder was last cleaned, certified, visually inspected. It is important to have confidence the 'residue' (heels) are inventoried and reported, as over time or in large facilities these can add up to very significant quantities.

It is probable the 'owners' of UF_6 cylinders want to know the location of their cylinders. One important question is determining the location of all UF_6 cylinders containing declared LEU. If all manufacturers and handlers use the same or compatible database systems to inventory the cylinders, it is easier to communicate between trading partners and IAEA.

What can be done to improve or supplement current IAEA tracking? Assuming we want to have complete tracking of UF_6 cylinders, at a minimum in an international tracking system, what are some of the options?

It would require all States to agree to report movement of UF_6 cylinders to the system. To be effective, the system should include domestic movements in all States including the NWS. It would include tracking both the material in the cylinders and empty cylinders. Since IAEA safeguards does not track origin or ownership of nuclear material, one question is would it be more attractive to all fuel cycle companies and their States to set up a separate tracking system? Would an extension of the IAEA capability or a separate tracking system be more effective for both the commerce and non-proliferation objectives?

Extend or supplement IAEA tracking

If emphasis is put on the cylinders themselves and in confirming tracking is done, then the already existing IAEA databases and activities may be the best place for that to be performed. Since all movements for NNWS transfers are tracked based on the nuclear material, it remains to consider the NWS, which report cylinders if they contain more than 1 EKG. If it is determined that the 1 EKG limit results in unreported transfers (it would for heels) either it would be necessary to remove the 1 EKG limit or require UF_6 cylinders be tracked in all cases regardless of weight. The interesting result of this would be recognizing the need to track certain types of fuel cycle equipment even when 'empty', retaining the requirement to report the material details in the case where material is present including amounts less than the 1 EKG threshold.

If the IAEA reporting system is to be updated to track UF_6 cylinders there are several changes to reporting procedures and data field content that would need to be made.

- Require all States to use the cylinder identification as the batch name for all UF_6 transfers. This may present a problem for those transfers of cylinders with an identification more than eight (8) characters long and where the State has a Code 10 format with fixed data field sizes. The batch name length issue is a technical matter of nuclear material reporting to the IAEA. It should be noted there are many States who have a Code 10 document that permits reporting of longer batch names.
- Addressing the uniqueness of cylinder identification if serial numbers are duplicated. Working with manufacturers to see what they need to do to accommodate this.
- For NWS export/imports under INFCIRC/207, remove the 1 EKG limit and have all exports and imports reported.
- Have the NWS report the relevant data elements for the Batch Name and Material Description Code under INFCIRC/207 and, if possible, the KMP Code, and Measurement Basis Code as well.
- The issue of reporting requirements for exports/imports between NWS civil sectors would need to be addressed, that is for those transfers where neither side of the transaction is under IAEA safeguards. This would close one open point with respect to reporting cylinder transfers and would be viable especially if all transactions, including those < 1 EKG, were reported.
- Solving the ownership issue of cylinders is currently outside the responsibility of the IAEA. The IAEA does not have a mandate to follow the ownership of a cylinder as it is transferred from one State to another. The contained nuclear material is what is considered to be under safeguards. Without an NPT requirement to follow ownership, the IAEA would not capture the necessary location information to know where a State's cylinders were.

There are potential obstacles to overcome with including this expanded tracking capability within the IAEA system. How difficult would it be to get agreement from all parties to send more information to the IAEA as opposed to creating a new international system controlled by the suppliers? How difficult would it be to solve the above issues with respect to the tracking system and new requirements? Depending on how we approach the task, what information will be required and whether it will be a voluntary offer. A mandatory offer could require a SAGSI review or even need to be addressed by the Board of Governors. Other issues to consider include what changes would be necessary for State nuclear material accounting systems and reports. We know that NNWS report to the IAEA one batch of UF_6 as one cylinder in a single nuclear material accounting entry. Are the individual facilities currently tracking the cylinders' ownership and serial numbers in their MBA accounting systems, or separate business related systems? How will the answer to this impact their ability to send more detail information to an international tracking system?

Perhaps the IAEA tracking system is not the best place to collect the information about UF_6 cylinders. Adding a new requirement to tracking types of containers puts a burden

on the IAEA system with very important non-proliferation goals. The IAEA database system has a safeguards support role and is particularly targeted for the IAEA main function to monitor and support the NNWS. With nuclear energy gaining momentum, it is important the IAEA has the resources to work closely with new States implementing nuclear power plants and monitor for nonproliferation treaty (NPT) compliance. Tracking and monitoring UF_6 cylinders might be better in the hands of an industry group with a strong IAEA integration.

The States most interested in assuring UF_6 cylinders are not being diverted are the nuclear suppliers. With the new international fuel centers, focused on the assured fuel supply, commerce and peaceful use of nuclear material are a major interest of the States supplying the fuel. It might make sense to engage one of the international centers to operate a UF_6 cylinder tracking system. This could be supported by the group most concerned and users of the cylinders, some formal or informal arrangement among UF_6 supplier states or even nuclear supplier firms.

If the IAEA is not the owner and operator of the tracking system, what assurance do we have that it will be comprehensive, accurate and with timely reporting? An agreement between companies and countries involved in commercial activities is common. Accuracy and complete data requires cylinders are 'born' tracked and the manufacturers of cylinders report create unique serial numbers and report shipment. An initial reporting of all cylinders (when the cylinder is born/manufactured) would set up the tracking system. After the initial report, cylinders would be reported whenever they are shipped and received. It is important to consider reporting the nuclear material characteristics in the cylinder to this tracking system. This type of information is standardized for reporting to the IAEA, so it is already being tracked by the States.

There are some important requirements for the system in order to have confidence in the data. The operator of the system must have the ability to ask for clarification and correction if data seems incorrect. One simple example is two cylinders with the same serial number. Does this mean the cylinder moved without being reported, or, maybe just transposed numbers? The owners of the tracking system will require a report of all the cylinders and their location, perhaps annually. If there is a problem that seems to indicate a diversion or theft, the owners of the tracking system need the authority to report to the IAEA there is an issue for action. Another question is handling the security of each State's or company's information. Who can access what information needs specific agreements in place.

Conclusions

Regardless of how "tracking" is defined, UF_6 cylinders as equipment are indicative of the existence and movement of a specific type of nuclear material and activities. Therefore, can we conclude there is value to the individual fuel supplier States and the international nonproliferation community? Perhaps one goal is on the part of the States involved in the fuel cycle who need to be confident cylinders being distributed outside their boundaries are not being diverted from their intended use. The international community is interested

in nuclear energy but needs confidence the increased use of nuclear energy does not lessen confidence in the non-proliferation regime.

How this can be accomplished and how effective it might be is a discussion for all parties. Depending on the needs of the concerned parties and the rules under which it operates, the IAEA could be the best organization to be responsible for the proposed expanded tracking of UF_6 cylinders.

Databases already exist at the IAEA where nuclear material transfers and inventories are recorded on a batch basis. The IAEA is tracking all related NNWS nuclear material and in the same process following the batches, which also means a single cylinder. To track the individual cylinders themselves, NNWS reports should ensure that the cylinder identification is reported at the birth of the cylinder and for transfers and inventories. With expanded INFCIRC/207 information, more detailed levels of NWS reporting would be available.

Are the opportunities afforded by the creation of international fuel centers and the expected growth in nuclear commerce a basis for establishing a tracking system for this important indicator? Should the IAEA data system be enhanced to require reporting movement of uniquely identified UF_6 cylinders, even when empty? It is important to consider the risk and benefit of tracking the UF_6 cylinders and be confident that there is real value added before we embark on a difficult and lifelong task. Engagement with the supplier countries and companies is one way to start a dialog on the value of being assured of the location and use of the material they are supplying. Can tracking UF_6 cylinders with or without material, taking into account tare weight, cleaning and recertifying to obtain accurate accounting, provide one needed element in strengthening the safeguards regime?

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